ENDOGENOUS MODELING OF LATE ENTRY PENALTIES

FOR PACKAGED GOODS

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ABSTRACT

This paper extends previous single equation analysis by the authors (1992) which found significant innate order of entry penalties that were modified by promotion, price, distribution and advertising levels. In this paper endogenous effects of order of entry on the marketing variables and the decision to enter early itself are captured in a recursive structural equation model of market share. The statistical analysis of this extended model finds significant relationships between order of entry and the level of marketing variables. In addition, significance is found in the correlation between entry order and the expected market share of the new product and the rate of growth of earnings per share, but not the size of the firm. Surprisingly, the endogenous effects increase rather than decrease the size of the innate market share penalty for late entry relative to the value estimated in the original single equation model.

INTRODUCTION

Numerous previous papers have documented the empirical relationship of early entry with market share advantages (e.g. Robinson 1988a, Robinson and Fornell 1985, Urban et. al. 1986, Perry and Bass 1989). Recently Kalyanaram and Urban (1992) studied the dynamic effects of later entry on market share in packaged goods with a single equation model. The purpose of this paper is to extend that model by examining endogenous effects that could change the estimated magnitude and significance of the order of entry penalties. We briefly review their single equation model and results and then propose a structural equation model that examines the endogenous effects of order of entry on marketing variables and the possibility that order itself is endogenous and a function of the skill and power of the firm. We present the empirical results of applying the new model to the original data, examine the existence and magnitude of the innate order of entry effects, analyze the sensitivity of the structure, and close with an identification of directions for future research.

The Kalyanaram and Urban (1992) model is shown in equation 1. It states that share is a function of order of entry, marketing variables, product quality, and time dynamics [1].

$$S_{it} = E_i^{\alpha} D_{it}^{\beta} P_{it}^{\gamma} M_{it}^{\delta} A_{it}^{\theta} Q_i^{\epsilon} (1 - e^{-\phi t - (\psi / E_i) t}) \qquad (1)$$

[1] See Kalyanaram and Urban (1992) for a complete description of the model and estimation.

S_{it} = Ratio of share of ith brand to share of first brand to enter the category as of period t

E_i = Order of entry of ith brand, i = 2, 3, ... N

D_{it} = Ratio of distribution of ith brand to distribution of first brand in period t

P_{it} = Ratio of price of ith brand to price of first brand in period t

M_{it} = Ratio of promotion of ith brand to promotion of first brand in period t

A_{it} = Ratio of advertising expenditure of ith brand to advertising expenditure of first brand in period t

Q_i = Ratio of quality of ith brand to quality of first brand

t = Time period since the introduction of brand i to the market

$\alpha, \beta, \gamma, \delta, \theta, \epsilon, \phi, \Psi$ = Parameters

The ratio of share of the nth brand to the first entrant is a nonlinear function of the order of entry times the effects of marketing variables (ratioed to the first entrant) all raised to an exponent. This suggests there is an "innate" order of entry effect (E^α) that is modified by marketing actions and product quality. The final term in equation 1 reflects a decreasing marginal rate of growth to an asymptote and is described by an exponential function which depends on the order of entry of the brand.

Nonlinear time series cross sectional statistical procedures were used to estimate the parameters of the model (eq. 1) based on data from Behaviorscan UPC data and <u>Leading National Advertisers</u> from 18 later entrants (order of entry 2 or greater). Significant results were found for all variables at the ten percent level and the order of entry penalty was -.4

(see table 1 for a review of the original single equation results).

There are two major threats to the validity of the model arising from possible endogenous entry phenomena. First the marketing variables may themselves be a function of order of entry. For example, the level of advertising may be systematically lower for later entrants. If this is not modeled, the "innate" order effect may in fact be the structure of spending of later entrants and not a true market penalty. Similar arguments apply to price, promotion, and distribution.

The second threat is that entry itself may be endogenous. Vanhonacker and Day (1987) discussed this as an example of an area where reverse regression is relevant. Moore, Boulding, and Goodstein (1991) explicitly suggest that entry may be a function of the skills and resources of the firm. When this is true, they show that the underlying order effect will be biased and may even be of opposite sign. They do not build an endogenous model for order of entry effects, but they show the dangers of ignoring the effect in estimation.

In this paper we develop an explicit simultaneous equation model that includes the endogenous effects of order of entry on the levels of marketing variables and the entry order itself. We apply it to the original Kalyanaram and Urban data and examine the effects of model structure on the estimation of the innate order effect.

RECURSIVE EQUATION MODEL

The first equation in our new model is the same one discussed above (eq. 1). We add equations for each of the marketing variables and entry where each variable equation is similar in form. The variable, say promotion (M), is modeled as a function of the order

of entry of the brand, the market share of the brand 12 weeks before, and relative promotion lagged 12 weeks:

$$M_{it} = E_i^{\mu_1} \ \overline{M}_{it-12}^{\mu_2} \ S_{it-12}^{\mu_3} \ U^{\mu_4} \tag{2}$$

where

$$\overline{M}_{it} = \frac{\sum_{\substack{j=1 \\ j \neq i}}^{N} M_{jt}/N-1}{\sum_{j=2}^{N} M_{jt}/N-1} \tag{2a}$$

U = constant

$\mu_1, \mu_2, \mu_3, \mu_4$ = parameters

The inclusion of order of entry as an endogenous factor allows us to examine our first threat to the validity. If the variables are determined by order -- say late entries systematically have lower promotion -- the variable substituted in equation 1 will reflect this fact. The market share is included based on the notion that market share may cause promotion rather than promotion causing share. If more share allows the firm to "afford" more promotion expenditure, this simultaneity should be included in a good model. We make the relationship recursive on the assumption that it takes some time (say 4 weeks) to

learn of share changes and some time (say 8 weeks) to implement the changes that will be seen in the market. With weekly and even daily UPC shares available the lags may be shorter, but we feel these lags are appropriate for the period we will analyze (1983-88). We report sensitivity to number of lag periods later in this paper.

A term to reflect promotion of competitors ($\overline{M}$) is calculated as the average promotion of other brands (all brands except the ith brand). This term is designed to capture the reactions of our promotion to competitors. If competitors increase promotion we may react after an appropriate lag (again assumed as 12 weeks) to match their increases. This competitive reaction could affect the estimation of the order of entry parameter if the reduction of shares of later entrants was because early entrants reacted to the competitive new product effort and defended their share. The apparent share penalties in this case would be due to competitive reaction and not innate order of entry. The relative competitive price variable is ratioed to a similar relative price for the leader in the spirit of equation 1 where we ratio all variables to the first brand to enter (see equation 2a).

The original model in equation 1 does include some competitive effects by ratioing the promotion variable of the nth entry to the first entry, but the new model (eqs. 1 to 5) provides a more comprehensive structure to remove any competitive phenomena from the estimation of the innate order of entry effect by modeling competitive effects on share and on the variable levels themselves.

Similar equations are developed for price, distribution and advertising.

$$P_{it} = E_i^{\rho_1}\ \overline{P}_{it-12}^{\rho_2}\ S_{it-12}^{\rho_3}\ V^{\rho_4} \tag{3}$$

where

$$\overline{P}_{it} = \frac{\sum_{\substack{j=1 \\ j \neq i}}^{N} P_{jt}/N-1}{\sum_{j=2}^{N} P_{jt}/N-1} \tag{3a}$$

V = Constant

ρ_1, ρ_2, ρ_3, ρ_4 = parameters

$$D_{it} = E_i^{\omega_1}\ \overline{D}_{it-12}^{\omega_2}\ S_{it-12}^{\omega_3}\ W^{\omega_4} \tag{4}$$

where

$$\overline{D}_{it} = \frac{\sum_{\substack{j=1 \\ j \neq i}}^{N} D_{jt}/N-1}{\sum_{j-2}^{N} D_{jt}/N-1} \tag{4a}$$

W = constant

ω_1, ω_2, ω_3, ω_4, = parameters

$$A_{it} = E_i^{\eta_1} \, \overline{A}_{it-12}^{\eta_2} \, S_{it-12}^{\eta_3} \, X^{\eta_4} \tag{5}$$

where

$$\overline{A}_{it-12} = \frac{\sum_{\substack{j=1 \\ j \neq i}}^{N} A_{jt}/N-1}{\sum_{j=2}^{N} A_{jt}/N-1} \tag{5a}$$

X = constant

η_1, η_2, η_3, η_4 = parameters

The final equation of our model describes entry as a function of expected market share and the firm's size and performance. If the firm is accurate in predicting share potential, we would expect entry to be early where share potential is high and later where it is low (see Prescott and Visscher 1977 and Lane 1980). We begin by assuming perfect foresight and use the maximum share achieved by the nth brand as the measure of share potential. Later in this paper we relax the assumption of perfect forecasting and examine the sensitivity of imperfect foresight on the model's parameters.

We use the size of the firm introducing the nth brand as a surrogate for market

power. Large firms like Proctor and Gamble would have large sales values and small firms like the White Mountain Wine Cooler Company would have small sales values. If size is a good predictor of entry we would expect the coefficient to be negative (larger size leads to smaller order of entry values). As a surrogate for skill we use the average rate of growth of earnings per share over 5 years. This presumes that firms with high earnings per share growth are doing their management job better than other packaged goods firms. The entry equation is cross sectional and is:

$$E_i = \tilde{S}_i^{v_1} R_i^{v_2} Z_i^{v_3} Y^{v_4} \qquad (6)$$

where

$\tilde{S}_i$ = anticipated share defined as maximum market share of ith brand divided by the first brand,

R_i = ratio of average earnings per share growth over five years for ith brand to average earnings per share over five years for the first brand,

Z_i = ratio of total dollar sales for brand i's firm to the total dollar sales for first brand's firm in 1986,

Y = Constant,

v_1, v_2, v_3, v_4 = parameters.

DATA AND ESTIMATION

Our data reflects 18 later entrants in the categories of: tartar control toothpaste, hi-fiber cereals, frozen orange drink, frozen pineapple juice, wine coolers, microwave popcorn, gel tooth paste, and ibuprofen pain relievers.[2] The data are based on store level UPC measures in eight markets for share, distribution, price and promotion provided by IRI. Across the 18 later entrants there were 1241 weekly observations providing an average of 69 weeks per entry. Advertising expenditure data was obtained from Leading National Advertisers. One measure is missing in the data to support equation one -- product quality. We use a brand specific dummy to capture brand quality and other unique brand attributes not specified in the model.

Estimation was done by three stage non-linear least squares methods (SAS "sysnlin") applied to the system of equations (eq. 1-6) after log transforms had been applied to each equation. Table 1 shows the new and old model estimation results.

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[2] We would like to acknowledge and thank Information Resources Inc. for providing this data to us. The data represents 8 IRI BEHAVIORSCAN (tm) cities. The data includes store scanner records from over 75 supermarkets and 25 drug stores over the period October 31, 1983 to January 15, 1988.

TABLE 1

SHARE EQUATION

		Recursive Equation Model Estimates	Single Equation Model Estimates
R^2		70%	91%
Parameters			
Asymptotic Entry	$-\alpha-$	-0.79	-.40
		(-18.33)***	(-14.02)***
Distribution	$-\beta-$	-0.20	.70
		(1.63)	(13.74)***
Price	$-\gamma-$	-0.82	-.31
		(6.43)***	(8.18)***
Promotion Dollar	$-\delta-$	0.04	.33
		(1.40)	(30.97)***
Advertising Expenditure	$-\theta-$	0.19	.04
		(16.62)***	(6.71)***
Growth Term constant	$-\phi-$	0.33	2.93
		(1.70)*	(1.94)*
Rate of Growth	$-\psi-$	-0.57	-5.64
		(-1.60)	(-1.87)*

Brand Specific Constants

Brand 1	-.30	-.42
	(-1.82)**	(-7.45)***
Brand 2	-.91	-.42
	(-7.02)***	(-13.38)***
Brand 3	.06	-.85
	(.059)	(-8.57)***
Brand 4	-.41	-3.37
	(-3.32)***	(-4.67)***
Brand 5	.22	.03
	(1.64)*	(.40)
Brand 6	.52	.49
	(2.09)**	(5.58)***
Brand 7	-.75	-.83
	(7.11)***	(-8.70)***
Brand 8	-.42	-.46
	(2.93)***	(-7.25)**
Brand 9	-.02	-.67
	(-1.02)	(-7.61)***
Brand 10	.02	.40
	(.87)	(4.49)**

Brand 11	-.02	.31
	(-.73)	(3.59)***
Brand 12	.01	.36
	(-.24)	(4.14)***
Brand 13	-.02	-.29
	(.77)	(-2.65)***
Brand 14	.02	-.29
	(.94)	(6.08)**
Brand 15	.01	-.79
	(-.39)	(-13.77)***
Brand 16	.01	-.62
	(.32)	(-10.31)***
Brand 17	.01	-.32
	(.19)	(-8.32)***

(-) = t value

*** 1%

** 5%

* 10%

PROMOTION EQUATION (R^2 = 16%)

Entry Order	μ_1	-0.69
		(-3.28)***
Promotion Reaction	μ_2	0.09
		(-3.28)***
Share	μ_3	0.43
		(8.39)***
Constant	μ_4	0.23
		(0.91)

PRICE EQUATION (R^2 = 8%)

Entry Order	ρ_1	0.20
		(4.44)***
Price Reaction	ρ_2	-0.04
		(-0.49)
Share	ρ_3	-0.02
		(-2.51)**
Constant	ρ_4	-0.26
		(-5.25)***

DISTRIBUTION EQUATION (R^2 = 30%)

Entry Order	ω_1	-0.24
		(-4.61)***
Distribution Reaction	ω_2	0.01
		(0.94)
Share	ω_3	0.16
		(13.08)***
Constant	ω_4	0.15
		(2.36)**

ADVERTISING EQUATION (R^2 = 41%)

Entry Order	η_1	-3.73
		(-7.30)***
Advertisement Reaction	η_2	0.48
		(8.36)***
Share	η_3	1.54
		(11.99)***
Constant	η_4	6.28
		(10.12)***

ENTRY EQUATION (R^2 = 37%)

Anticipated Share	ν_1	-0.20
		(-12.08)***
Average % Change in Earnings per Share Growth	ν_2	-0.32
		(-6.40)***
Total Sales of the Company	ν_3	0.03
		(0.72)
Constant	ν_4	1.21
		(100.93)***

In the share equation the R^2 value is 70% and the entry, price, advertising, and growth terms are significant. The fits in the share equation are lower than in the previous single equation analysis (70% versus 91%) and the market entry parameter is more significant and larger in magnitude. This means that after adding the endogenous entry phenomena, the innate penalty (α) for late entry is larger than before. Comparing the new parameters for the moderating marketing variables to the single equation case indicates that the new values for distribution and promotion are lower and show less significance, but price and advertising parameters have greater magnitudes and are significant at the 10% level in the recursive equation structure. The constant in the dynamic term is significant at the 10% level, but the rate of growth term is not. Both of them are similar in sign to the original values and their magnitudes are lower, but they continue to suggest that later entrants approach lower asymptotic share values faster than earlier entrants. In the structural equation model fewer of the brand specific dummies are significant and their magnitudes

are generally smaller. Adding the new equations to the model resulted in some of the previous brand specific effects being captured in the other model parameters. The significant values of dummy variables in the new model are similar to their counterparts in the original single equation model.

The promotion equation indicates that entry is significantly correlated to promotion expenditure. Later entrants spend systematically less on promotion (i.e. later entrants -- higher order of entry -- are associated with lower values of promotion relative to the pioneer). Share is also significantly related to promotion with higher shares being correlated to higher promotion expenditure. The R^2 value is modest at 16% so considerable variation can be expected in the estimated values of promotion that are used in equation 1 to predict share.

Similar significance in the relationships between entry and price, advertising, and distribution are found. Later entrants have higher prices, spend less on advertising, and obtain less distribution coverage. Share is positively related to each of the variables indicating high share is correlated with lower prices, higher advertising, and more distribution as would be expected.

The competitive reaction terms are insignificant in three of four cases. Only in advertising is there a significant relationship between the nth brand's marketing variable level and the lagged average variable level for competitors. As the advertising of other firms increases the nth brand advertising tends to increase after a 12 week lag. The lack of large competitive effects is consistent with the findings of Robinson (1988b) based on PIMS data. Share and entry effects on the marketing variables appear to be more significant and larger

than competitive reaction effects.

Order of entry itself (eq. 6) is found to be significantly related to the expected maximum share. Higher share expectations are correlated with earlier entry (lower entry values). The change in earnings per share are negatively correlated with entry order and significant at the one percent level. Financially successful, growing firms tend to be earlier entrants in this packaged goods industry. These findings support the notion that entry is not exogenous, but rather an endogenous phenomena related to the firm's skill and strategy of entering high potential markets early. Size of firm is not correlated to entry, so we have no evidence of firm and scale correlation to early entry in this data.

Overall the effects of entry on the level of variables and the endogenous entry value itself are very significant in this data. However even after these significant effects are found, the innate order of entry market share penalty (α) in equation 1 is preserved. In fact, the penalty increases in magnitude rather than decreasing or disappearing. This implies that there is an underlying market generated penalty for late entry even though later entrants have lower promotion, advertising, distribution levels and higher prices. Similarly early entrants have good foresight and high firm financial performance, but this does not remove them from being subject to market share penalties if they do enter late.

SENSITIVITY

We tested the model sensitivity to equation structure, number of lag periods (see eq. 2 to 5), and imperfect foresight (eq. 6). See table 2.

TABLE 2: SENSITIVITY ANALYSES

(a) STRUCTURAL EQUATIONS

	Asymptotic Entry (α)
Share Equation Only (eq. 1)	-.40
	(-14.02)***
Share Plus Marketing Efforts Equations (eq. 1 to 5)	-.79
	(-18.39)***
Share Plus Entry Equations (eqs. 1 and 6)	-.52
	(-17.39)***
Share Plus Marketing Efforts Plus Entry Equations (eqs. 1 to 6)	-.79
	(-18.33)***

(b) TIME PERIOD LAGS (WEEKS)

Lag Weeks	
12	-.79
	(-18.33)***
8	-.67
	(-16.37)***
4	-.72
	(-19.13)***
0	-.71
	(-22.19)***

(c) FORESIGHT

mean	-.78
	(-16.41)***
standard variance	.04

Table 2a shows the innate order of entry parameter values (α) for the case of the single share equation (eq.1), share equation plus the marketing variables (eqs. 1 to 5), share equation and entry (eq. 1 and 6 only), and the full model (eqs. 1 to 6). In all cases the innate order of entry parameter is significant, negative and larger in magnitude than the single share equation model (eq. 1).

In table 2b the order of entry parameter is estimated for the complete model (eqs. 1 to 6) with zero, four, eight, and twelve week lags in the response to share changes and competitors in the marketing variable equations (eq. 2 to 5). The values are similar in all cases and suggest that the model results with respect to innate order of entry are not sensitive to the lag period.

Finally we examined the sensitivity of the estimation to a lack of perfect foresight in predicting the maximum share ($\tilde{S}$, in eq. 6). We calculated the standard deviation across the 18 observed maximum shares and assuming a normal distribution conducted 25 simulated estimations. In each simulation the maximum share for each brand was defined as the observed data plus the value from a random draw from the normal distribution (o, σ). The average order of entry parameter (α) was -.78 (see table 1) and almost identical to the new model value of -.79. The standard deviation of the estimated order of entry parameters was

.04. Overall the estimation of order penalties is robust with respect to imperfect foresight on the share potential of a new brand in our model equations.

CONCLUSION AND FUTURE RESEARCH

Modeling the endogenous relationship between order of entry and the level of promotion, price, distribution, and advertising and the relationship between order of entry and expected share and the firm's financial performance, leads to an increase in the magnitude of the estimated innate penalty for late entry. This finding supports theories that argue for structural underlying phenomena that account for why the customers grant early entrant advantages based on economics (e.g Lane 1980, Schmalensee 1982, and Hauser and Wernerfelt 1990) and behavioral information processing (e.g. Sujan 1985 and Alba and Hutchinson 1987). Our statistical results support previous empirical statistical and experimental analyses that found pioneering rewards (e.g. Robinson and Fornell 1985, Urban, et. al. 1986, Robinson 1988, Carpenter and Nakamoto 1989, and Kardes and Kalyanaram 1992).

The strategic implications of our model are that a share reward can be obtained by early entry but this effect can be overridden by aggressive marketing by later entrants. Conversely later entrants should expect to obtain a lower share even if they have a product that performs at a parity level and has the same marketing support levels as the pioneer. Our data indicates that such parity is not common because we observe later entrants have higher prices and lower promotion, distribution, and advertising levels. Despite this observation, the early entrant would be wise to preempt the potential product positioning

advantages of later entrants and aggressively support their brand if they want to secure maximum share advantages. The firms that are most likely to enter early are those with demonstrated skill as measured by the growth in earnings per share and foresight in identifying high share potential market opportunities.

Although our recursive equations demonstrate statistical and managerial significance which are useful in understanding entry phenomena, if a manager were forecasting the potential of entering a new market, the original single equation model would be more appropriate than the recursive structural equation model. The order of entry and marketing variable levels would be known so the new equations would not be needed to predict entry values and marketing variable levels; the loss of estimation precision in equations 2 to 5 could be avoided.

Two directions of future research are evident. First our model could be extended to account for the time between entrants (Brown and Lattin 1990) and include structures that assess how enduring the entry advantage is (Robinson and Huff, 1991). We currently do not include the interval between entrants or the length of time the pioneer was in the market before a second brand entered. The second direction of research is to find the fundamental causes of the innate order of entry effect. Because behavioral and economic phenomena might explain the effect, more behavioral experiments are needed to uncover the underlying causative relationship between market share and order of entry.

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